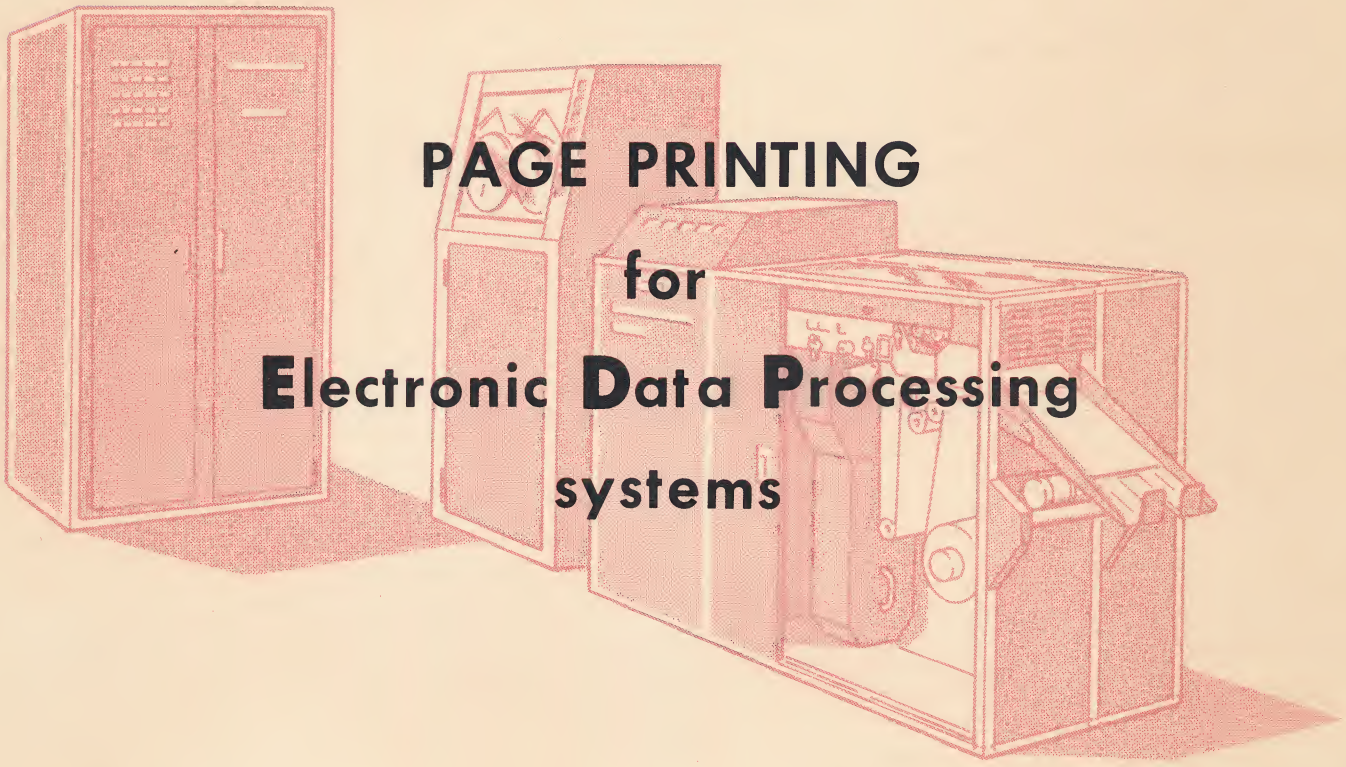
VIDEOGRAPH



PAGE PRINTING

for

Electronic Data Processing

systems

A·B·DICK®

VIDEOGRAPH®

A. B. DICK VIDEOGRAPH SERIES 904 PRINTER/PLOTTER

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INTRODUCTION

This presentation describes the Videograph process and A. B. Dick Company's capabilities in meeting the O.E.M. requirements of digital computer manufacturers for high-speed printing equipment.

A. B. Dick Company has designed and manufactured Videograph electrostatic printing equipment since 1959. A primary application of this equipment is in systems involving digital computers.

O.E.M. MARKETING

OBJECTIVES

A. B. Dick Company believes that the speed and flexibility of Videograph equipment provides new uses for modern general-purpose computers through combined systems applications. Experience indicates that the best arrangement is when the Videograph printer forms a component of an integrated system in which one of the new low-cost, highly versatile, computers serves as a central processor. Technical and marketing considerations make it desirable for the computer manufacturer to furnish Videograph printing equipment on an O.E.M. basis to the end-user. The advantages of single-responsibility in the procurement of main frame and peripheral equipment are clearly apparent.

For these reasons, A. B. Dick Company is negotiating O.E.M. arrangements with computer manufacturers where the use of Videograph equipment provides joint interests. Not only does this approach offer a broader marketing base, it permits more attractive economics through higher production levels.

This presentation is intended as an introduction. The company solicits the further study and consideration of specific Videograph applications; and the services of qualified personnel are available for these purposes. Videograph systems for computer page printing and other uses may be inspected at the company's plant in Chicago, Illinois.

In connection with its O.E.M. program, A. B. Dick Company offers full support with respect to market research, sales back-up, sales and service training, engineering assistance, and design.

CAPABILITIES

COMPUTER PAGE PRINTING	CRT DISPLAY SYSTEMS
COMPUTER PLOTTING/PRINTING	VIDEOFILE BLOW-BACK
ADDRESS-LABEL PRINTING	MICROFILM BLOW-BACK
HIGH-SPEED COPY REPRODUCTION	DATA EDITING
HIGH-SPEED FACSIMILE TRANSMISSION	RAILROAD CAR RECORDING
VIDEO RECORDING	APERTURE CARD BLOW-BACK
ELECTRONIC CHARACTER GENERATOR	DOCUMENT SCANNING
ELECTRONIC PHOTOCOMPOSITION	DISPLAY/PRINTING SYSTEMS

CUSTOMER APPLICATIONS

AMPEX CORPORATION	Videofile Blow-Back
BECKMAN INSTRUMENT COMPANY (THE BOEING CO.)	Computer Plotting/Printing
CURTIS PUBLISHING COMPANY	Address-Label Printing
DENVER & RIO GRANDE WESTERN RAILROAD COMPANY	High-Speed Facsimile
OFFICE OF CIVIL DEFENSE	Computer Page Printing
REUBEN H. DONNELLEY CORPORATION	Address-Label Printing
ESQUIRE, INCORPORATED	Address-Label Printing
FAWCETT PUBLICATIONS	Address-Label Printing
GENERAL ELECTRIC COMPANY	Character Generation
GRANGER ASSOCIATES	Video Recording
HOFFMAN ELECTRONICS (USAF)	CRT Display Systems
LOCKHEED MISSILES DIVISION	Computer Plotting/Printing
MARTIN COMPANY	Character Generation
McCALLS CORPORATION	Address-Label Printing
McGRAW HILL, INCORPORATED	Address-Label Printing
MEREDITH PUBLISHING COMPANY	Address-Label Printing
MEREDITH PUBLISHING COMPANY	Electronic Photocomposition
MERKLE PRESS	Address-Label Printing
NATIONAL GEOGRAPHIC SOCIETY	Address-Label Printing
NATIONAL PUBLISHING COMPANY	Address-Label Printing
NEO-DATA SERVICES, INCORPORATED	Address-Label Printing
NEW YORK CENTRAL RAILROAD COMPANY	Railroad Car Recording
NORTH AMERICAN AVIATION - ROCKETDYNE DIV.	Computer Plotting/Printing
R.L. POLK AND COMPANY	Address-Label Printing
READER'S DIGEST ASSOCIATION, INC.	Character Generation
REPUBLIC ELECTRONIC CORPORATION	Address-Label Printing
TIME INCORPORATED	Address-Label Printing
TRIANGLE PUBLICATIONS, INC. (TV GUIDE)	Address-Label Printing
U.S. NAVY DEPARTMENT - PUBLICATIONS DIV.	High-Speed Copy Reproduction
U.S. POST OFFICE DEPARTMENT	Bag-Tag Printing

A.B. DICK COMPANY

A. B. Dick Company has for more than 80 years supplied the graphic arts field with equipment and supplies for copy reproduction. Exhibit A describes the company's history, background, research and engineering facilities, and some of its key personnel. Continually seeking means for reproducing information at higher speeds and lower costs, in 1955 the company initiated studies to determine the feasibility of applying electronic and television techniques for this purpose. This program has lead to the development of many components and systems identified as VIDEOGRAPH DATA PRESENTATION SYSTEMS. They are proving to be of increasing importance as input and output sub-systems in the electronic data processing and communication fields — specifically in the areas of high-speed print-out and display. A. B. Dick Company's experience and background in these fields are believed to offer unique qualifications.

A. VIDEOGRAPH DATA PRESENTATION SYSTEMS

As indicated by the name Videograph, A. B. Dick Company's efforts in this field relate to the presentation of intelligible information to the human eye — either in printed page form or by human language display. In its broadest sense the Videograph concept is directed to the use of electronic techniques employing video or television-like electrical signals as a basic means of printing. The heart of the concept lies in the Videograph electrostatic printing process described in the following section.

A. B. Dick Company has made significant investment in the development and application of Videograph techniques and equipment. Since publication of Exhibit A (R & D Capabilities) new departments have been developed to handle the administration, marketing, and engineering of the Videograph program. Because of its nature, Videograph marketing and customer engineering activities are handled directly from the company's headquarters in Chicago rather than through the distribution channels for its other products.

B. APPLICATIONS

Videograph Data Presentation Systems have wide flexibility that results in broad applications. To date, Videograph concepts, designs, and developments have been used in the applications and customer installations outlined on the facing page.

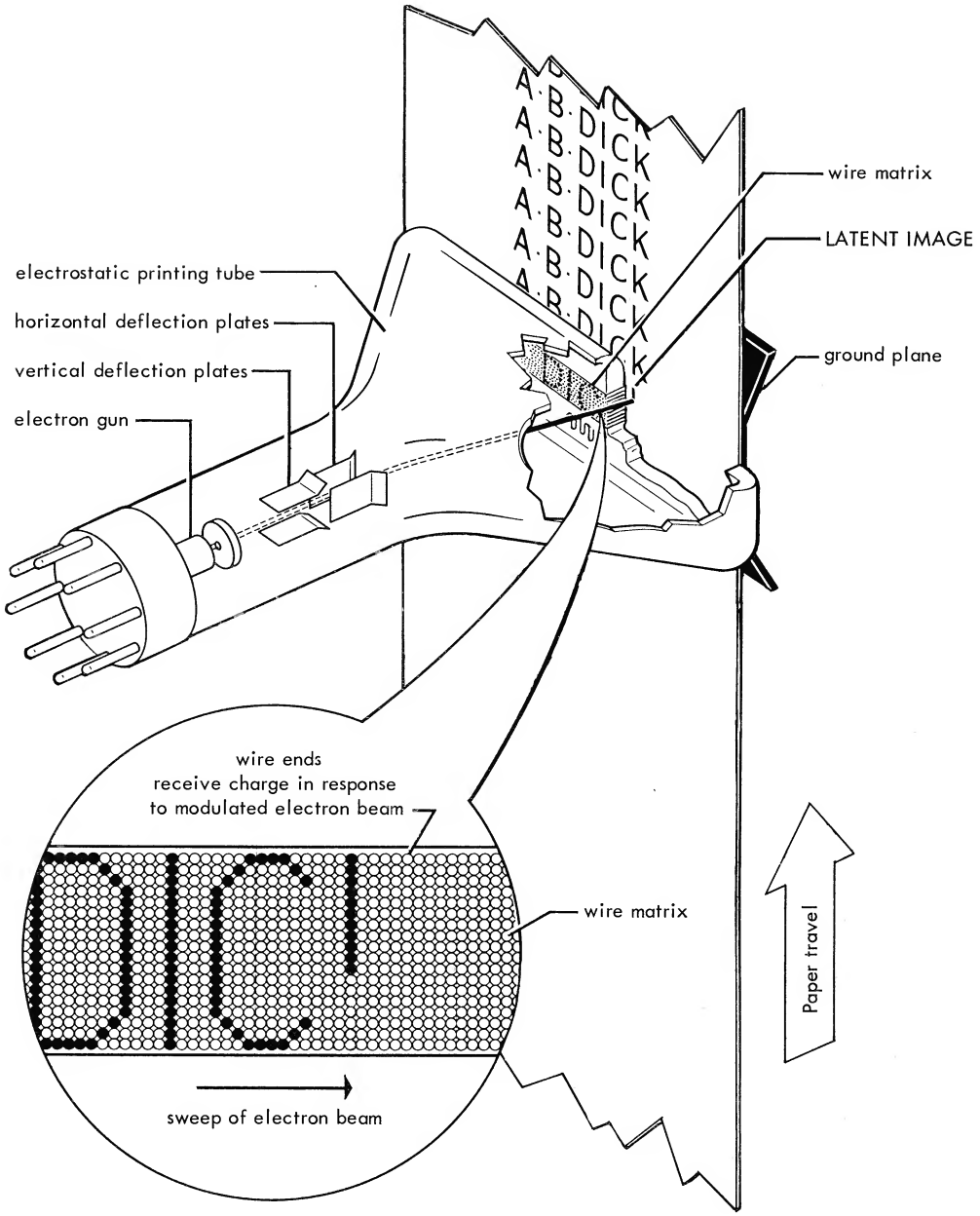


FIGURE 1. BASIC PRINCIPLE OF VIDEOGRAPH PRINTING WITH MATRIX TYPE CATHODE RAY TUBE

VIDEOGRAPH PROCESS

A principal objective in developing the Videograph process was to provide a reliable means for producing hard-copy output from pulse-coded systems at very high speeds. This electrostatic printing process has a theoretical writing range in excess of 250,000 linear inches per second. Videograph equipment is now available with paper speeds of up to 180 feet per minute — more than three times faster than other electrographic techniques, such as xerography.

A. ELECTROSTATIC PRINTING

The electrostatic printing tube (EPT) used in Videograph systems is a special cathode-ray tube similar to a television picture tube. In the EPT the conventional phosphor screen is replaced with a matrix of fine, metal wires fused through the face-plate. In standard EPT's the wires (.001" in diameter) are spaced .004" apart and in rows .004" from center to center, forming a two-dimensional array having a density of 62,500 wires per square inch.

A deflection system moves the electron beam of the EPT across the inner ends of the wires in response to video-type electrical signals derived from an input control system. Deflecting and modulating the beam across the matrix, while simultaneously moving a web of dielectrically coated paper across the outer ends of the wires, creates latent electrostatic images on the paper's surface (Figure 1). These charge patterns are subsequently made visible by applying a developing material or toner, which adheres to the charged areas. Both dry and liquid toners are available. With dry toners the developed images are made permanent by heat fusing. Liquid toners comprise a dyed resinous powder suspended in a carrier liquid. After developing, the liquid toner is air-dryed and forms a permanent black image. Videograph paper is white, similar to conventional bond paper. It is receptive to pen, pencil, ball-point and other writing methods. In addition to the inexpensive dielectric coating, Videograph paper is treated to stabilize its characteristics over a wide humidity range.

B. VIDEOGRAPH CHARACTER GENERATION

To provide compatibility with machine language systems, A. B. Dick Company has developed a compact, electronic decoder (designated the Model 980 Videograph Character Generator — Figure 2) which, when included in a Videograph printing system converts pulse-coded information into alphanumeric wave-forms. The wave-forms are used to modulate the EPT as shown in Figure 1.

The monoscope type character generator employs a special cathode-ray tube with a metallized target on which character shapes are imprinted with conventional printer's ink, usually in an 8 x 8 array, providing 64 different characters. The pulse-coded input selectively directs the electron beam of the monoscope tube to a desired character which is scanned by the beam in a small raster pattern. Differences in the emissivity of the black character and its metallized surround are detected. With appropriate amplification these signals modulate the beam of the EPT in the printer to create character-shapes on the Videograph paper. The standard Model 980 character generator has a transfer rate in excess of 15,000 characters per second. Figure 3 is a block diagram of the Model 980 character generator.

Unlike electronic character generators of the Lissajou, or shaped beam types, the Model 980 Videograph Character Generator features wide formatting flexibility, and the ability to reproduce character-shapes of any complexity. For example, the target may contain Roman, Gothic, or Italic fonts in both upper and lower case, or any special symbols desired by the customer. The reliability of the Model 980 has been amply demonstrated during nearly five years of continuous field operation.

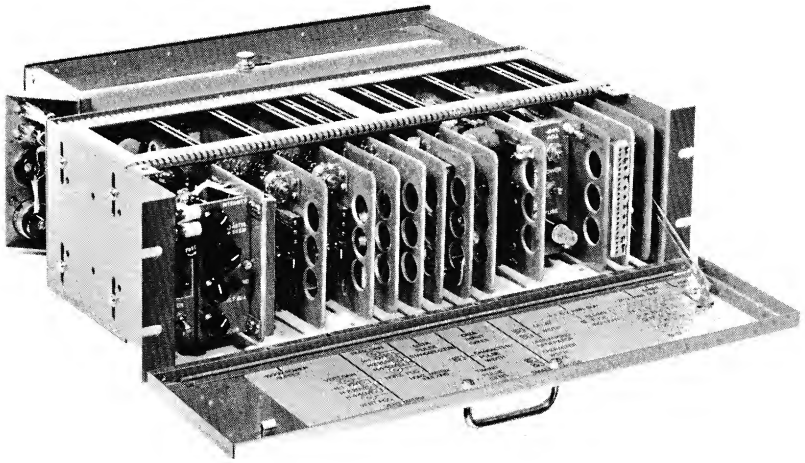


FIGURE 2. A. B. DICK MODEL 980 VIDEOGRAPH CHARACTER GENERATOR

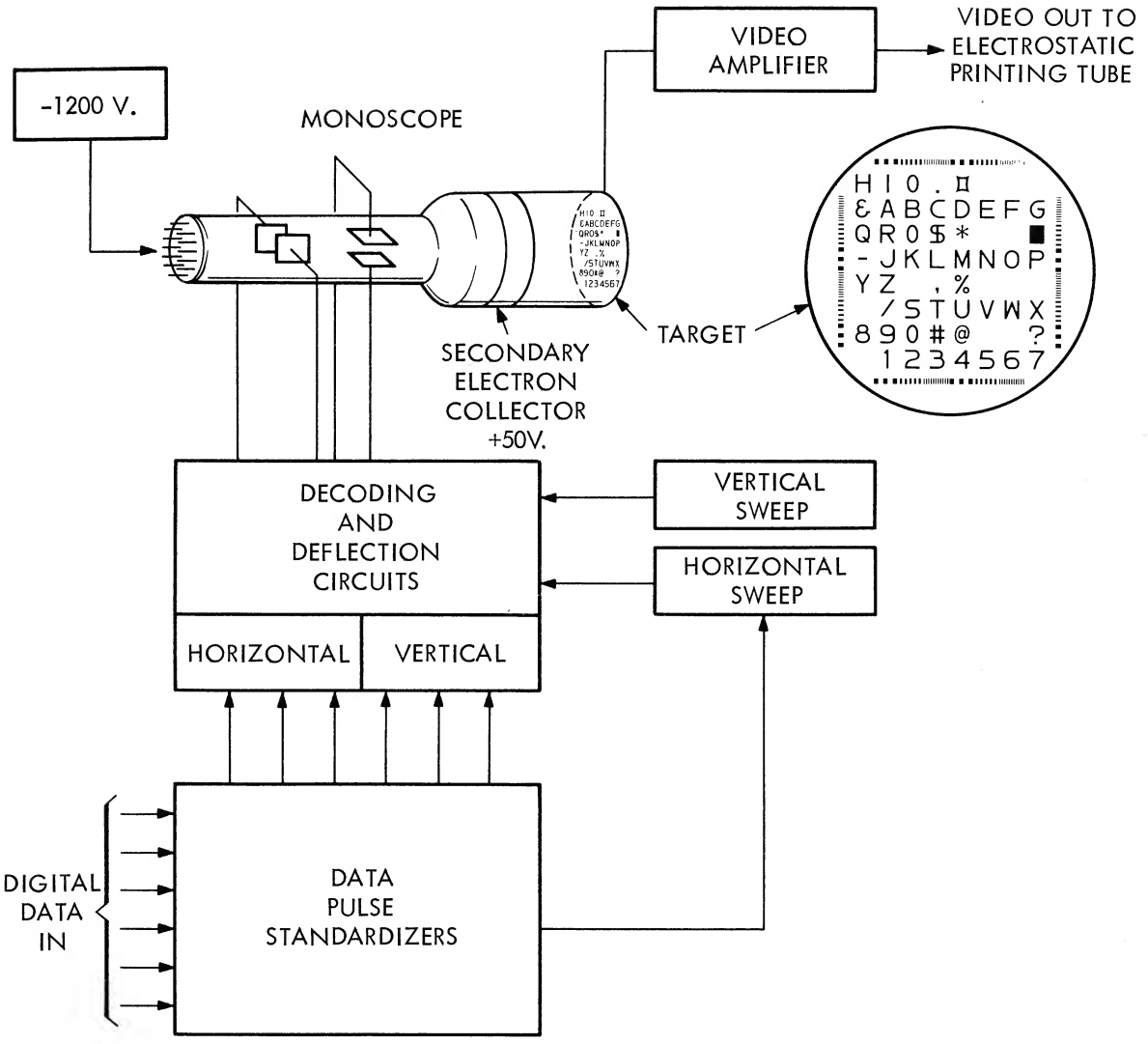


FIGURE 3. MODEL 980 VIDEOGRAPH CHARACTER GENERATOR — SIMPLIFIED BLOCK DIAGRAM

(a) .070" CHARACTER HEIGHT
15 CHAR./INCH
8 LINES/INCH

(b) .080" CHARACTER HEIGHT
15 CHAR./INCH
9 LINES/INCH

(c) .085" CHARACTER HEIGHT
9 CHAR./INCH
4 LINES/INCH

(d) .100" CHARACTER HEIGHT
9.5 CHAR./INCH
5 LINES/INCH

(e) .110" CHARACTER HEIGHT
8 CHAR./INCH
4.5 LINES/INCH

FIGURE 4. SAMPLES OF VIDEOGRAPH PAGE PRINTING SHOWING VARIABLE CHARACTER SIZE, HORIZONTAL POSITIONING, AND LINE SPACING

COMPUTER PAGE PRINTING

A. IMPACT PRINTING

Since the early 1950's, the need for higher volume output from computers in general purpose applications has required the development of higher speed printers. Early single character machines, such as the automatic keyboard types, have been replaced with faster impact devices with electronically activated drums, chains, and type wheels.

Most impact-type line printers operate from 200 to about 1500 lines per minute. This appears to represent the upper threshold of speed and reliability for this type of equipment.

Further evidence of the need for higher output speeds is shown in the increasing widths of computer printers. Early tab and line printers provided 80 columns of information at 10 characters per inch on an 8" wide printing field. Today, some types of printers provide 160 columns on 17" wide paper.

However, horizontal character density has remained fixed at 10 characters per inch because of physical liminations of the metal elements required in impact printing. Also, vertical line spacing has been generally accepted at 6 lines per inch. The information density of this type of printing is therefore 60 characters per square inch. Comparison of these characteristics with conventional hot-metal printing provides a clear indication that the criteria of impact printing of this type is dictated by mechanical limitations of the equipment, rather than established by readability and legibility to the human eye.

B. VIDEOGRAPH NON-IMPACT PRINTING

The Videograph non-impact printing process overcomes the speed limitations of impact printing because the electrostatic printing tube is virtually inertia-free. Thus, imaging speeds ten to twelve times faster than impact printers can be readily achieved. Printing at these high speeds is performed without noise or significant wear.

The Videograph process also features highly flexible formatting and produces output at much more efficient information densities. Character shape and size, aspect ratio, and horizontal and vertical spacing can be varied to suit different job requirements by simple electronic adjustments and by varying the paper web speed. This wide flexibility is illustrated in Figure 4. The Videograph process also permits continuous analog plotting and intermixing of alphanumeric annotations as shown in Figure 5. A further feature is shown in Figure 6 in which the characters are rotated 90° where wide formatting is desired.

The format range described before demonstrates capabilities of Videograph that are difficult or impossible to achieve with impact-printing. In addition to speed advantages, this versatility allows the computer manufacturer to offer associated OEM hard-copy output equipment capable of extending the usefulness of the computer to many new applications, and to effect significant cost reductions in existing ones.

Like other non-impact techniques, the Videograph process cannot produce multiple copies by using carbon-paper and similar copying media. Previously, this limitation has been considered a serious deterrent to the application of electrographic printing processes. And there is no question that in some computer printing, simultaneous multiple-copies are desirable or necessary. However, recent A. B. Dick market studies have developed several significant factors that minimize this requirement. These are:

- The growing use of computers for editing "look-up" type records requiring only a single copy, for example, subscriber registers in the publishing field, and daily loan registers in banking.
- The growing use of microfilm filing systems, eliminating the need for a second file copy.
- Cost reduction in operating supplies through the elimination of multi-part forms by re-running the magnetic file tapes.
- The elimination of bursting, collating, and slitting operations by re-running file tapes.
- Trends towards discouraging unnecessary copies by re-running the tapes as copies are ordered.

Videograph's higher output speeds add significant feasability toward the practice of re-running tapes. For example, a Videograph printer operated sequentially can produce the equivalent of approximately twelve copies before reaching an output break-even point with a 600 line per minute impact printer.

FIGURE 5. SAMPLE OF VIDEOGRAPH PLOTTING WITH ALPHANUMERIC ANNOTATION
(Copied from original with A. B. Dick Model 650 Office Copier)

FIGURE 6. SAMPLE OF VIDEOGRAPH PRINTING — 90° CHARACTER ROTATION

SERIES 904 PAGE PRINTER

A. DESIGN AND DEVELOPMENT

The first use of the Videograph process in computer-oriented equipment was in 1960 with continuous 2-3/4" wide printers for producing address-labels at rates in excess of 135,000 per hour. Machines of this type have been in heavy-duty field operation since that time. Design of the first 8 1/2" wide Videograph printer, designated the Model 9041 Videograph Printer/Plotter was begun in 1962. Three installations have since been completed for aerospace companies. A fourth installation was made recently for the Office of Civil Defense, in Washington, D.C.

For these applications, the Model 9041 Videograph Printer/Plotter (Figure 7) was especially designed to produce continuous plots of analog data (Figure 5) processed by means of a digital computer. A Model 980 Videograph Character Generator is included in the circuitry so that alphanumeric information may be printed out to identify and annotate the plots. Through appropriate programming of input information, the Model 9041 printer produces ordinates at various scales, time tics, and other indicia useful in graphic plotting.

The character generator also permits use of the Model 9041 as an 8 1/2" wide computer page printer, as shown in the examples of Figure 4.

Market research has provided clear indications that there are many applications for a machine of the Videograph Printer/Plotter's general configuration — especially as a high-speed computer page printer. Since some modifications may be necessary to adapt the Model 9041 design to these applications, the equipment's designation is generalized as the Model 904 Videograph Printer.

GENERAL DESCRIPTION

The Model 904 printer is high-speed continuous-duty type electrostatic equipment that produces 8 1/2" wide hard-copy output from pulse-coded electrical signals. The printer (Figure 7) comprises a unitary console housing the paper transport system, an 8 1/2" wide electrostatic printing tube, and the electronic circuits and components necessary for control and operation. Internal arrangement is shown in Figures 8 and 9. Exhibit B, a Service Manual for the Model 9041 Videograph Printer/Plotter, explains its operation and includes a detailed description of its physical characteristics.

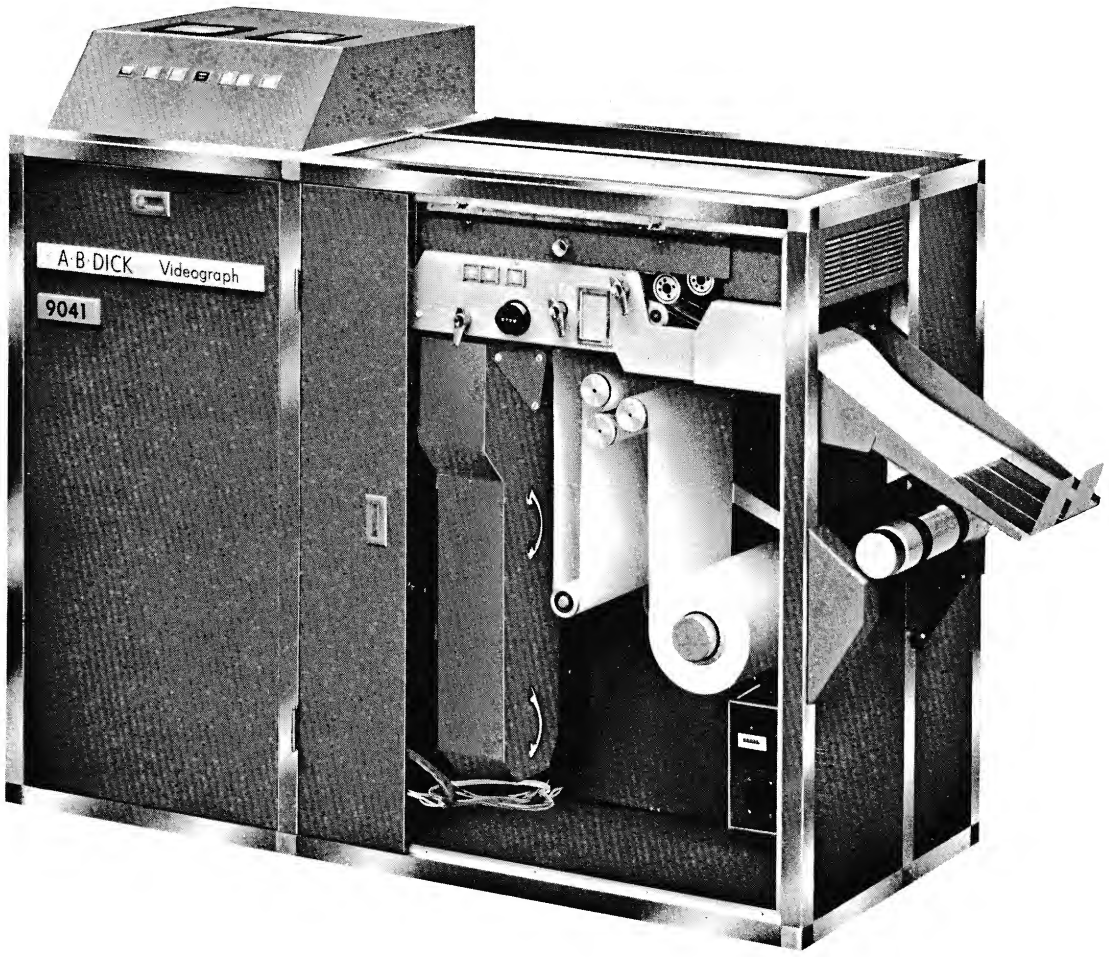


FIGURE 7. A. B. DICK VIDEOGRAPH SERIES 904 PRINTER/PLOTTER

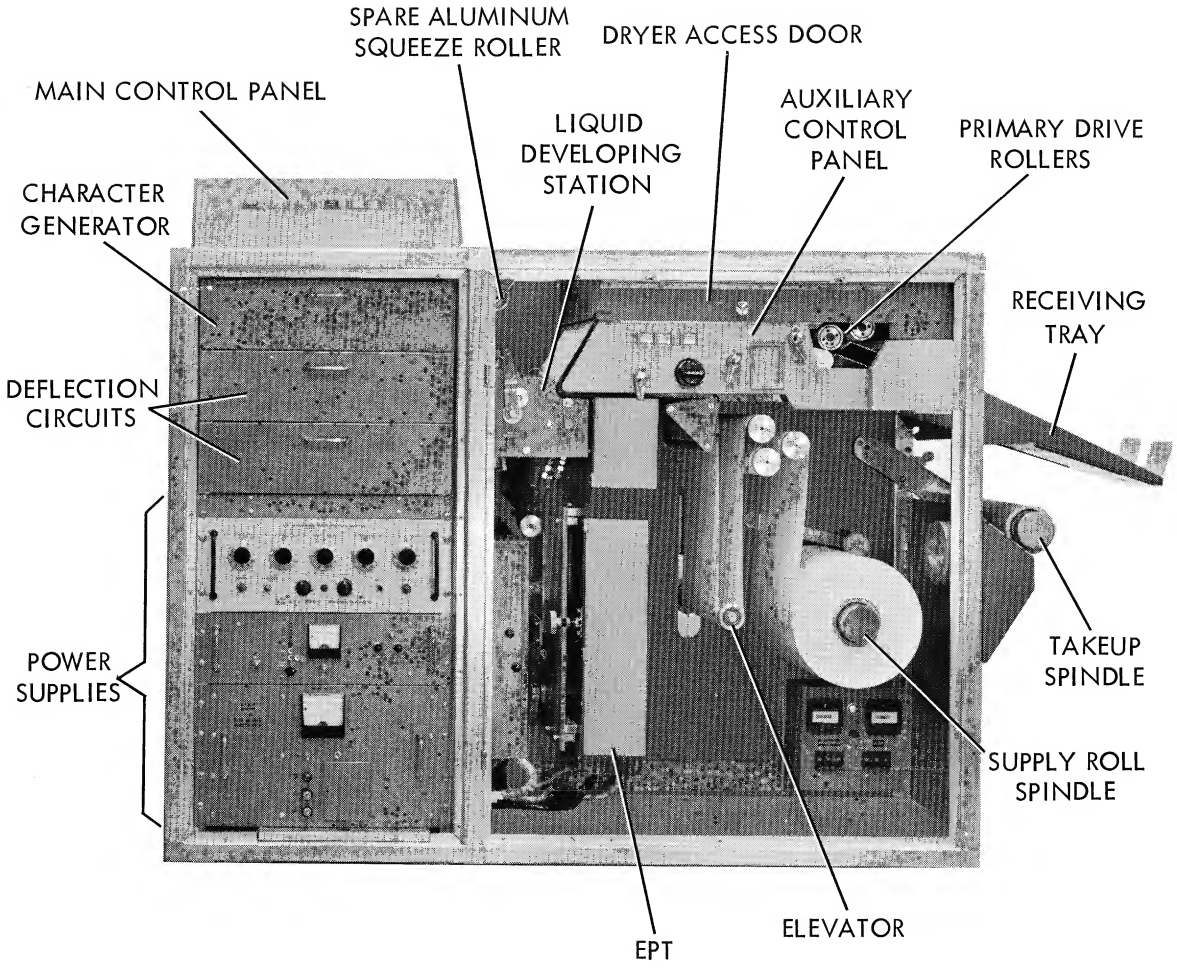


FIGURE 8. MODEL 904 VIDEOGRAPH PRINTER — FRONT VIEW

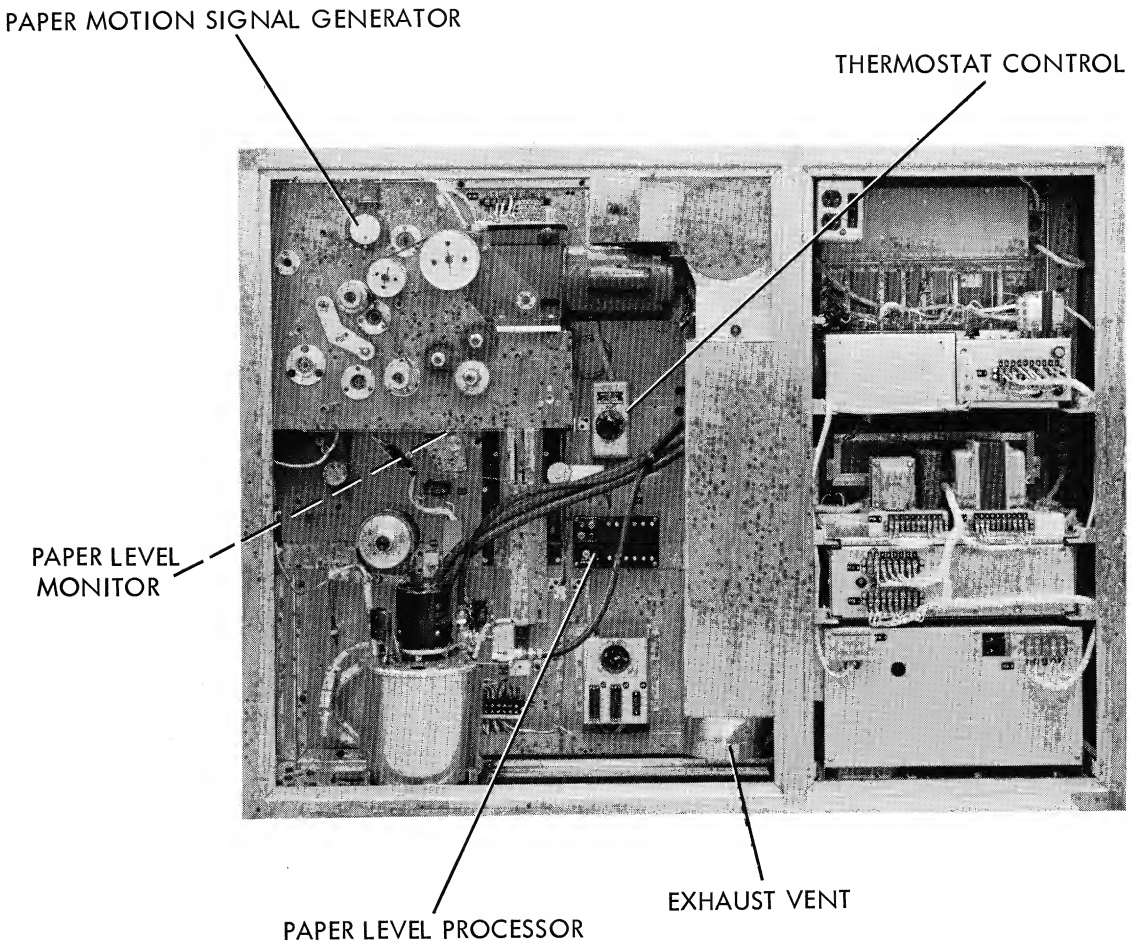


FIGURE 9. MODEL 904 VIDEOGRAPH PRINTER — REAR VIEW

INPUT

The Model 904 printer operates from pulse-coded input signals representing data information and control codes. The information must be delivered continuously at a rate compatible with desired web speed and output format. The data information controls deflection circuits in the printer which operate the monoscope for character selection and horizontal positioning. Line spacing is controlled by a transducer in the printer.

The printer automatically responds to control codes derived from the input control system for its various functions such as END-OF-LINE, START-OF-PAGE, END-OF-PAGE, SUPPRESS ZERO, etc.

Typical Videograph off-line printing sub-systems employ either a satellite digital computer operated from magnetic file tapes or a special printer control unit. Figure 10 is a schematic block diagram of a printer control unit for such a purpose. Essentially, the printer control unit performs these functions:

- Controls the associated magnetic tape unit to read the pulse coded information from the tapes into the printing system at the required rate. On receipt of an END-OF-ROLL signal, the control unit causes the magnetic tape unit to re-wind. In some systems, two tape units are used under automatic sequential control, so that one is reading the tape while the other is re-winding.

- Checks parity of the incoming information, and if an error is detected, causes the tape to be re-read until the error is detected.

- Stores incoming information in a magnetic core memory, and releases it to the printer at the desired continuous rate.

- Checks parity of the information directed to the printer.

- Provide signals required by the printer to establish the horizontal position of the printed characters.

- Provides the required clock for establishing the rate of the system.

- Detects the control codes for the operation of the printer.

A magnetic core buffer with a capacity of 4096 characters is shown in Figure 10. In such a system, input information is "blocked" on the magnetic tapes so that one-half of the buffer is employed to sequentially store information, while the other half is directing information to the printer.

In an on-line configuration, the functions described above are provided by the computer as a central processor.

OUTPUT

Output of the Model 904 printer is on Videograph paper in alphanumeric or graphic form. While the paper transport accomodates a paper web up to 11" in width, the printing field is limited to an 8 1/2" wide area in the center of the web. As presently designed, the paper may be automatically cut at a speed up to 10" per second or continuously rolled on a rewind spindle. The sheets are stacked in reverse collation order in a receiving tray.

CHARACTER SET

The monoscope character generator provides 64 different character shapes or symbols according to the customer's selection. A larger repertory may be provided by adding additional character generators.

CHARACTER SIZE AND LINE SPACING

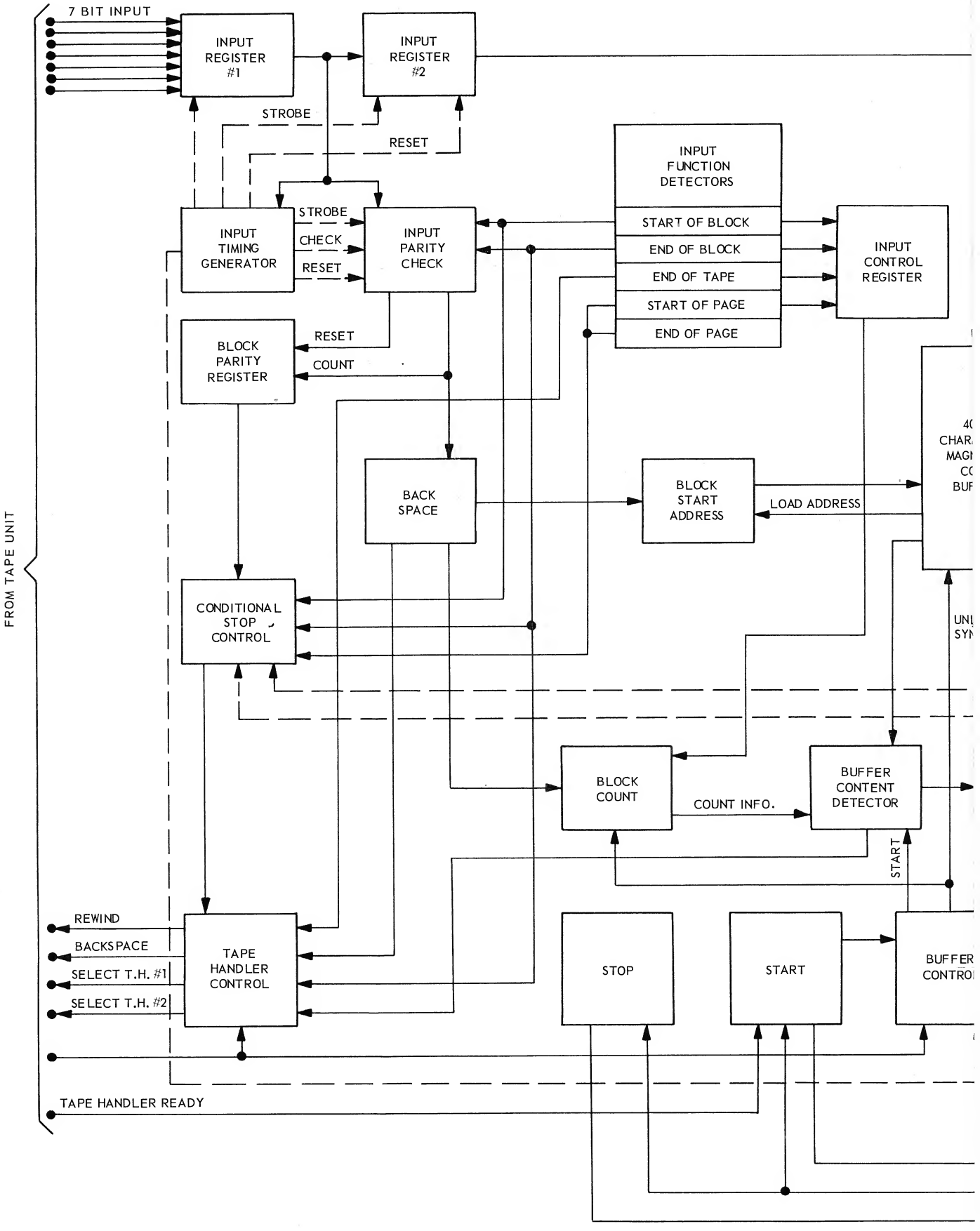
Height of printer characters may be varied from a maximum of 0.125" to a minimum of readability. Character width and horizontal spacing is also electronically variable, as is line spacing. Thus, the equipment has a practical range of up to 16 characters per inch when operated in a typewriter-like mode, and up to 10 lines per vertical inch.

SPEED

The web speed of the Model 904 printer is infinitely variable from 0.2" to 20.0" per second. While the low speed range is of use in applications requiring plotting, the practical speed range for computer page printing is between 12" and 17.5" per second.

The through-put speed is a function of line spacing and density within the maximum character generation rate of 15,625 characters per second. For example, at a web speed of 15" per second, the maximum permissible character density (characters per horizontal inch x vertical lines per inch) is:

$$\frac{\text{15,625 characters per inch}}{\text{8.5" width x 15" per second}} = \text{122 char./sq. inch.}$$


7 BIT INPUT
INPUT REGISTER #1
INPUT REGISTER #2
STROBE
RESET
INPUT FUNCTION DETECTORS
START OF BLOCK
END OF BLOCK
END OF TAPE
START OF PAGE
END OF PAGE
INPUT CONTROL REGISTER
INPUT TIMING GENERATOR
STROBE
CHECK
RESET
INPUT PARITY CHECK
BLOCK PARITY REGISTER
RESET
COUNT
BACK SPACE
BLOCK START ADDRESS
LOAD ADDRESS
CONDITIONAL STOP CONTROL
BLOCK COUNT
COUNT INFO.
BUFFER CONTENT DETECTOR
START
REWIND
BACKSPACE
SELECT T.H. #1
SELECT T.H. #2
TAPE HANDLER CONTROL
STOP
START
TAPE HANDLER READY
FROM TAPE UNIT

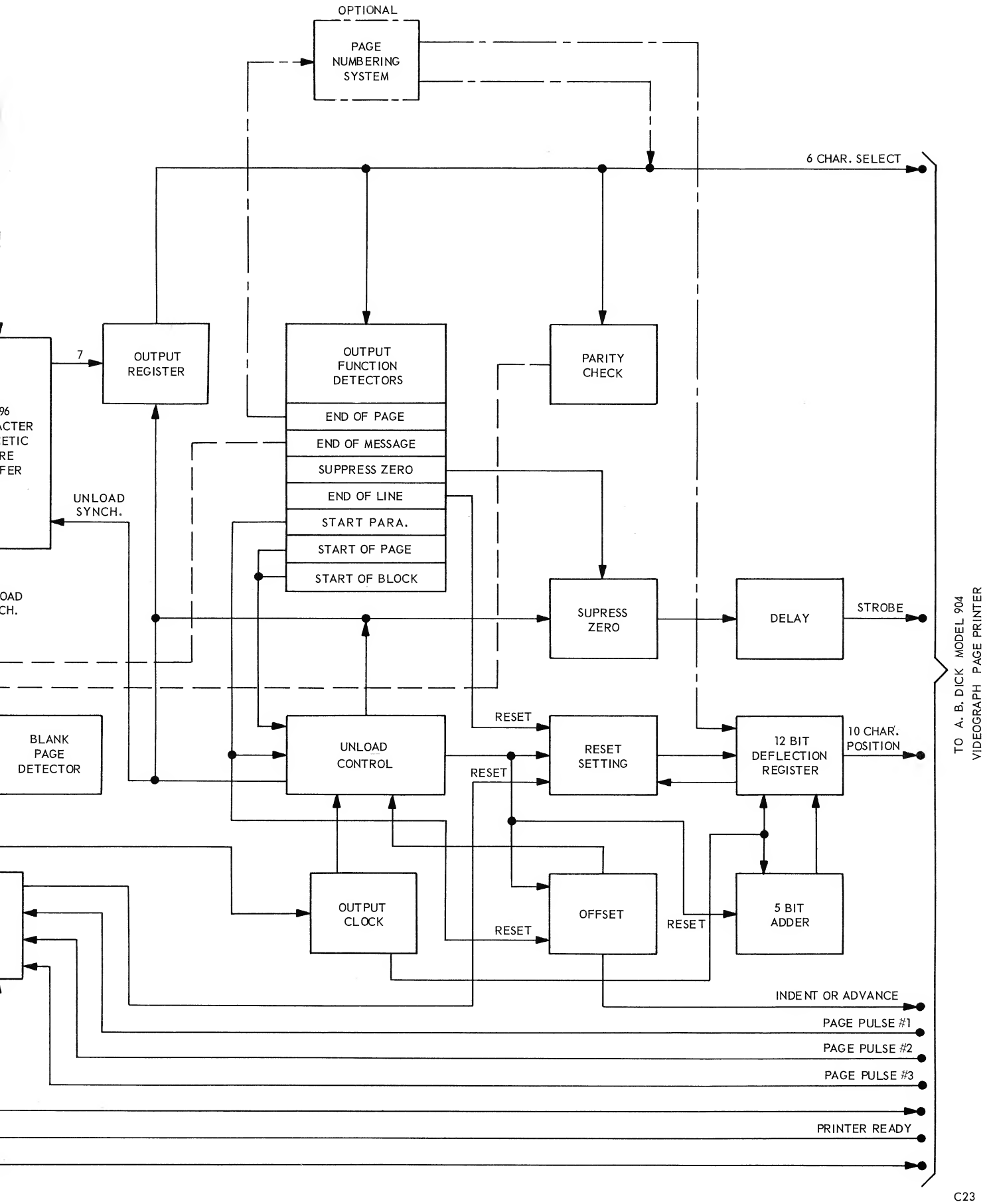


FIGURE 10. TYPICAL VIDEOGRAPH PRINTER CONTROL UNIT — FUNCTIONAL BLOCK DIAGRAM

Based on this parameter, the following table represents the through-put in lines per minute, when the printer is operated at 15" per second web speed, for several useful page formats.

THROUGH-PUT AT 15" PER SEC. WEB SPEED — 100% DUTY

CHARACTERS PER HORIZONTAL IN.	COLUMNS	LINES PER VERTICAL IN.	CHARACTER DENSITY	LINES PER MINUTE
10	85	6	60	5,400
10	85	7	70	6,360
11	93	7	77	6,360
11	93	8	88	7,200
11	93	8.5	93	7,650
12	102	8	96	7,200
12	102	8.5	102	7,650
14	119	8.5	119	7,650
15	127	8	120	7,200

OUTPUT PROCESSING

The present Model 9041 Printer/Plotter uses roll or cut-sheet output due to plotting requirements, which dictates relatively long output of indefinite length. Most conventional line printers use pre-printed forms, pre-processed to meet the application requirement for fan-folding, perforating, edge-punching, post-hole punching, etc. Other off-line operations performed after printing include bursting, collating, separating, cutting, and slitting.

The Videograph process best employs continuous rolls of dielectrically treated paper as delivered from the coating mills. The output of Videograph printing equipment can be post-processed on appropriate off-line equipment or by attachments included in the basic Videograph printer.

The Model 904 printer can be equipped with attachments to perform any of the following operations on the paper web after printing:

FAN FOLDING	POST HOLE PUNCHING
EDGE PUNCHING	SLITTING
TRANSVERSE PERFORATING	NUMBERING
EDGE PERFORATING	DATING
REVERSE COLLATION	CUTTING

A. B. Dick Company incorporates attachments for one or more of the foregoing operations in a number of its other products and the machines for manufacturing operating supplies. Inclusion of such attachments in Videograph equipment requires only the application of straight-forward engineering design.

ELECTROSTATIC FORM IMPRINTING

High quality, repetitive form imprinting may be electrostatically reproduced in the Videograph printing system by means of the arrangement shown in Figure 11. As shown, one or more rotatable spindles are supported below the paper track, ahead of the electrostatic printing tube. The spindles support interchangeable metal form imprint cylinders which have the desired form information photoengraved on their outer surfaces, much like printers' stereotypes.

The spindles are interconnected and driven so that the surface speed of the form imprint cylinders is the same as that of the paper. The form imprint cylinders contact the dielectrically coated side of the Videograph paper by means of conductive back rolls. Energizing the circuit (spindle, cylinder, and back roll) with a DC voltage creates high-quality latent electrostatic images of the embossed form on the paper web. The images are then developed simultaneously with the active information imaged by the EPT. Registration between the form imprint and the active information is maintained through electronic circuits controlling the spindle drive.

The printing of two or more different forms, such as an invoice and a receiving copy, can be achieved by using more than one form imprint spindle assemblies and appropriate switching circuits.

Figure 12 is an example of form imprinting produced by the above technique.

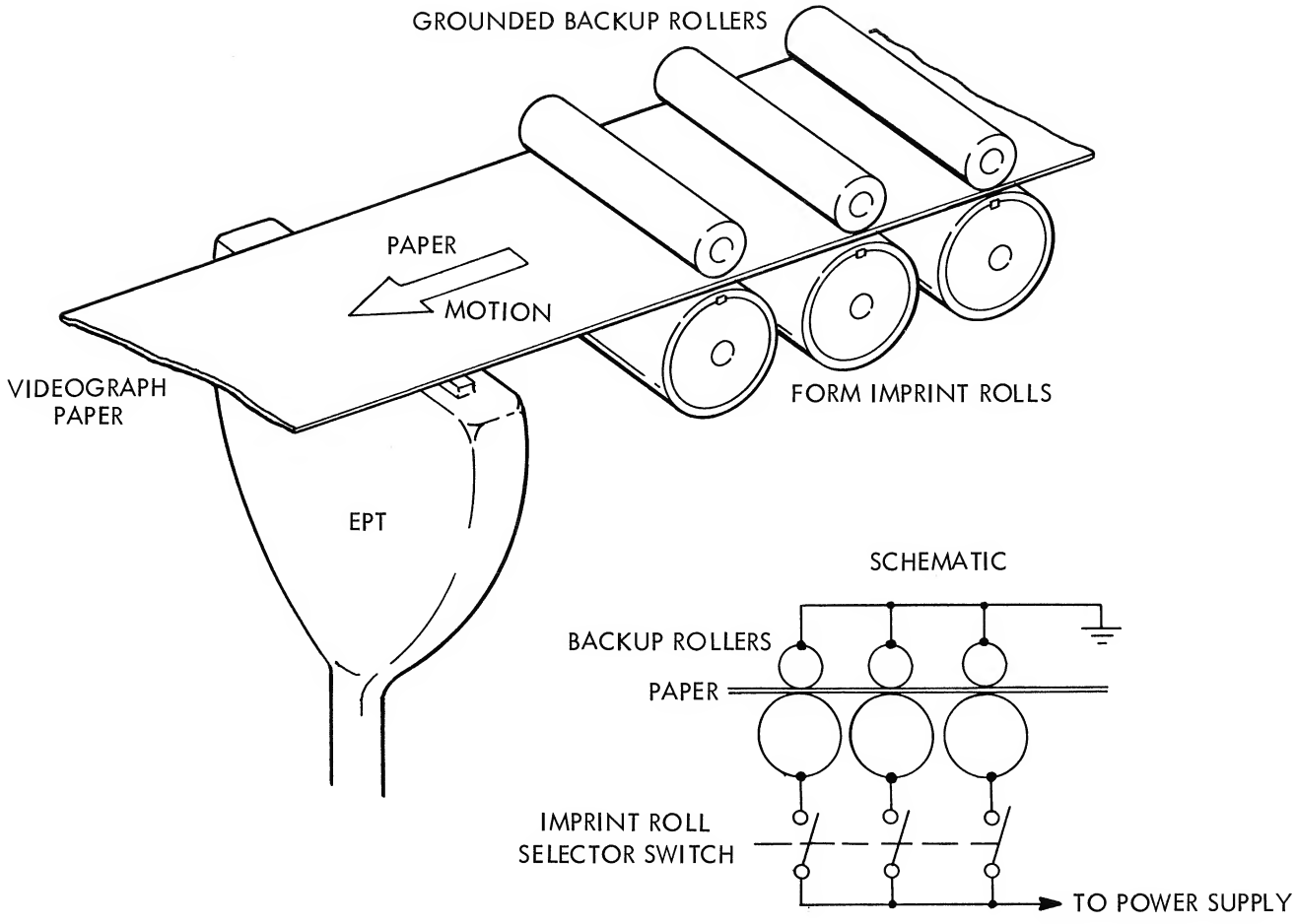


FIGURE 11. VIDEOGRAPH FORM IMPRINTING SCHEMATIC ARRANGEMENT

FIGURE 12. SAMPLE OF ELECTROSTATIC FORM IMPRINTING

GRAPHIC ARTS CHARACTERISTICS

Printers measure width and height of columns, margins, etc. in picas. In typography the pica is 12 points or approximately 1/6". A "Pica" font has been evolved to meet the characteristics of mechanical printing devices, such as typewriters, which has a format of 10 equally spaced characters per horizontal inch, and six lines per vertical inch. Impact printers (for computer use) conventionally employ upper case pica characters, resulting in a highly stylized form of printing of relatively poor readability and low information density. Again, this form is dictated by the physical limitations of the machines, rather than by good typographical practices. Quality of the image is low compared to hot metal printing because it must be struck through a carbon ribbon. These limitations preclude the use of impact line printers from many applications such as price lists, service manuals, etc. Where high quality is desired, the information generated from the computer is usually recomposed for conventional printing.

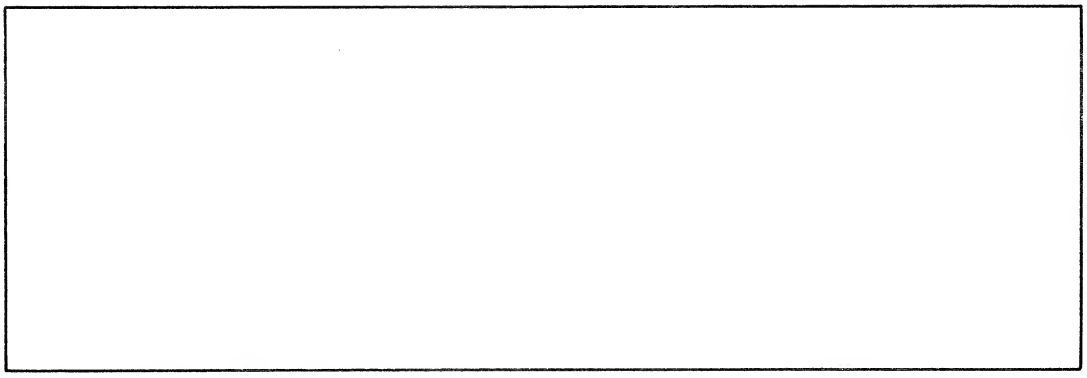
Literally thousands of type faces and fonts have been developed. While much of this effort has been for esthetic purposes, the primary criteria of a high quality font is readability and legibility. Combining good font design with the infinite character spacing permitted by conventional type composition provides both page economy and high information content. As an example, a telephone directory set in 7 pt. Bell Gothic contains approximately 275 characters per square inch — approximately 450% more information than if set in Pica.

Videograph printing eliminates the limitations of impact printers in the above respects, and permits the use of variable type forms, upper/lower case, variable type size, and proportional spacing. This capability improves the output efficiency of digital computers and provides a means for extending their applications.

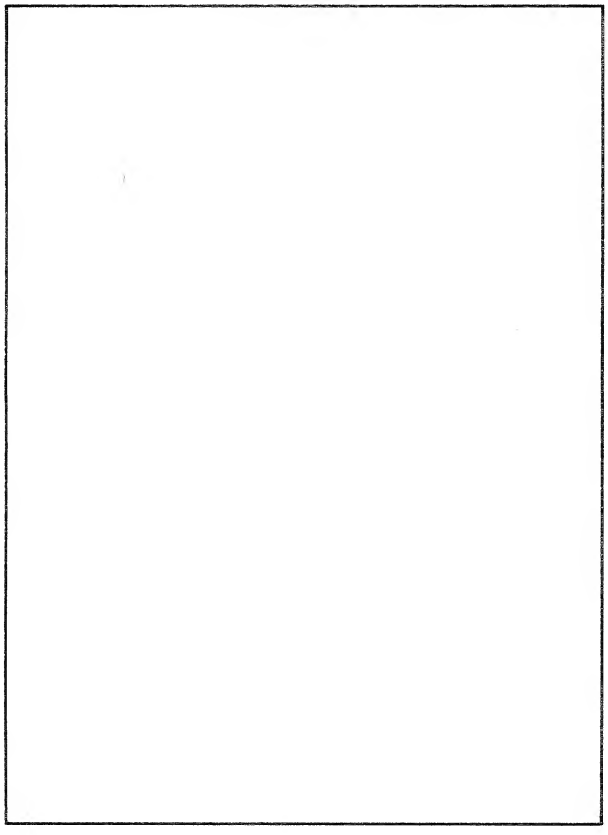
The deflection circuits normally included in Videograph printers are capable of positioning the writing beam of the EPT within .010" across the printing area. Appropriate computer programs can thus be employed to position each character horizontally, providing typographically correct character and word spacing.

These new and unique printing capabilities provide an opportunity to extend the use of computer systems and improve their performance. Examples of these additional uses include address-labels, price lists, reference lists, telephone directories, service manuals, and authors' proof for automated photocomposition.

Figure 13 illustrates how Videograph computer printing can achieve graphic arts quality, suitable for extended copy use (i.e. where copies are required for wide distribution). The Videograph sample at the top of the page (Figure 13) was produced from a high-resolution (200 lines per inch) electrostatic printing tube at twice the character height desired in the final form. A reproduction dummy was then made from the Videograph output, and an offset master produced at 50% reduction. The lower sample is an offset copy made from the master. The photographic reduction used in preparing the master results in a resolution of about 400 lines per inch on the printed page — nearly the quality of hot metal printing.



(a) SAMPLE OF VIDEOGRAPH PRINTING. 140" HEIGHT — 30 PICA MEASURE



(b) OFFSET COPY MADE FROM 50% REDUCED MASTER OF (a)

FIGURE 13. VIDEOGRAPH GRAPHIC ARTS PRINTING SAMPLES

B. SYSTEM CONFIGURATIONS

Videograph computer page printers are adaptable for a wide variety of on-line or off-line system configurations. Maximum flexibility is obtained when a computer is used for both processing and printer control purposes. Interface circuits provide compatibility with most general purpose computers, when used for this purpose.

OFF-LINE PRINTING SUB-SYSTEM

Videograph off-line printing systems are generally employed where fully-edited magnetic file tapes can be economically prepared on an associated main frame. This serves to relieve the main frame for other purposes while printing operations are being performed. Figure 14 is a schematic block diagram of such a Videograph printing system. As shown, the system includes a magnetic tape unit, a printer control unit, and the Model 904 printer. An optional second tape unit can be included for continuous operation. The printer control unit may be furnished by the customer, or by A. B. Dick Company to customer's specifications.

ON-LINE PRINTING SUB-SYSTEM — PAGE PRINTING ONLY

In many EDP operations employing one or more main frames, it is uneconomical to utilize the primary computers for sub-editing routines. In these cases, printing sub-systems are used including a satellite computer for both editing runs as well as printer control purposes. Previously computer characteristics required that these functions be carried out sequentially. Recently introduced computers have increased speed and memory capabilities that permit simultaneous I/O operations, such as editing and printing.

Figure 15 is a functional block diagram of a Videograph printing sub-system employing a computer as described above. For example, file tapes edited on a main frame can be re-edited for a sorting or conversion operation by means of the central processor, using tape units #1 and #2 as input and output equipment. After final editing, the tape can be re-introduced to the central processor using tape unit #3 for a simultaneous printing run.

ON-LINE SUB-SYSTEM LINE AND PAGE PRINTING

EDP operations often have work that can best be handled by means of a line printer, as well as other jobs where the speed of Videograph can effect cost and time savings. Figure 16 illustrates an on-line arrangement providing for simultaneous editing, Videograph page printing, and conventional line printing to provide the flexibility required by such work loads.

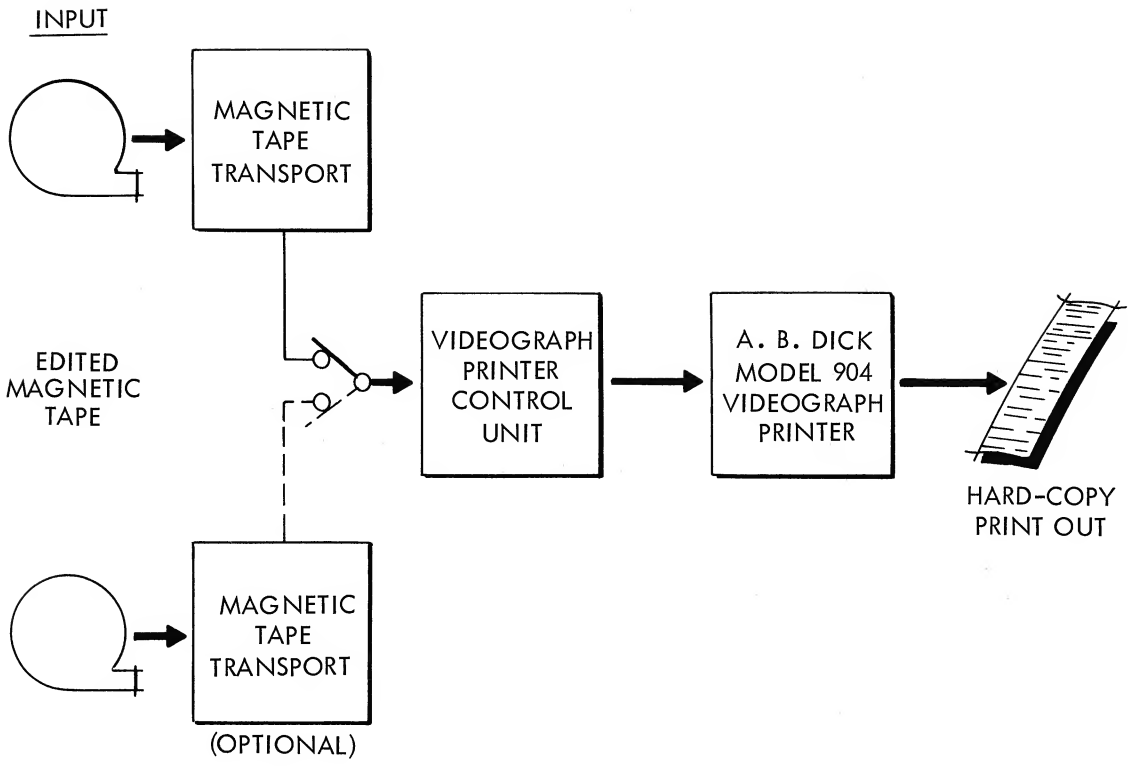


FIGURE 14. A. B. DICK VIDEOGRAPH HIGH-SPEED PRINTER SYSTEM

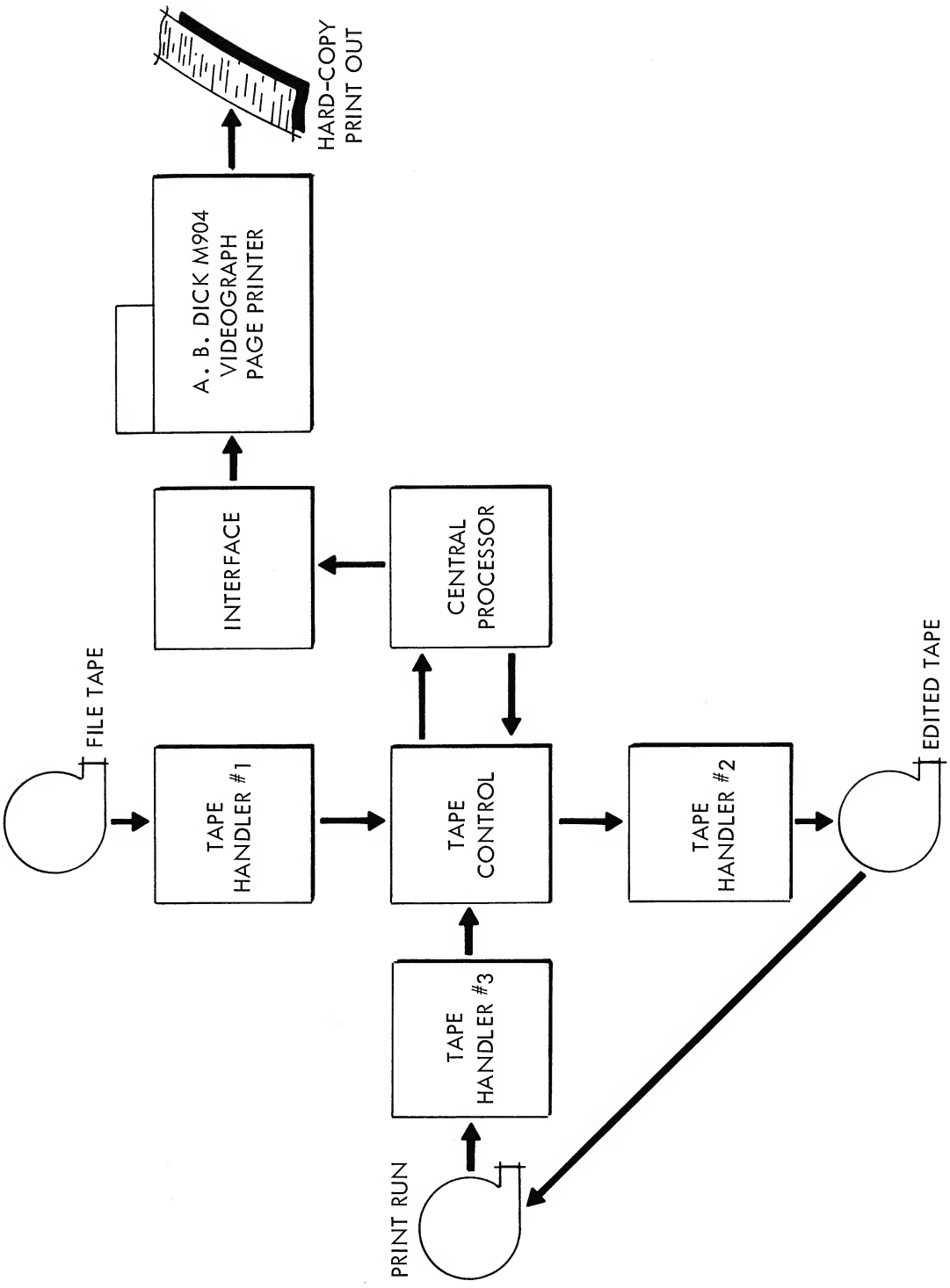


FIGURE 15. ON-LINE PRINTING SUB-SYSTEM
SIMULTANEOUS EDIT & PRINT

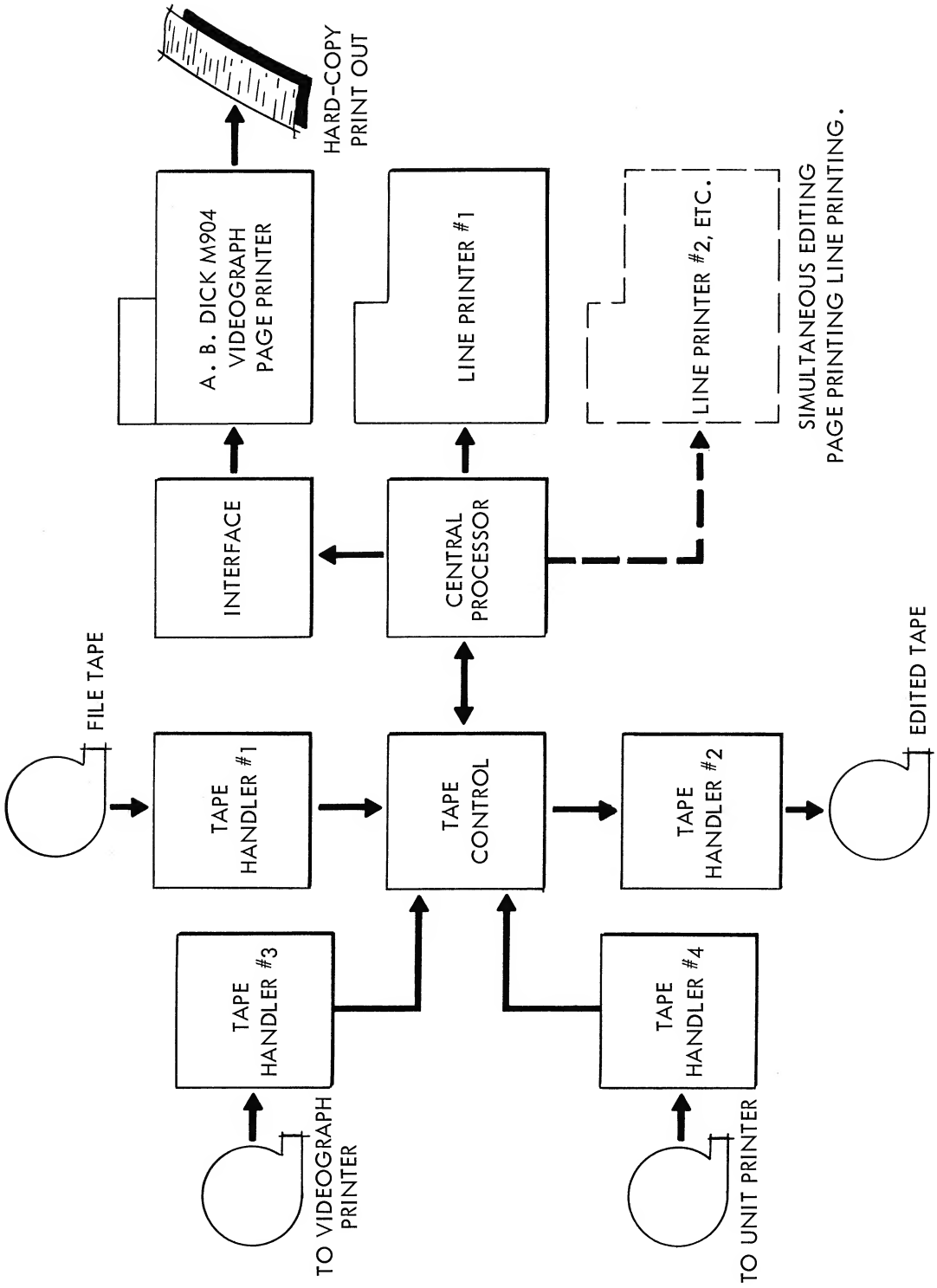


FIGURE 16. ON-LINE PRINTING SUB-SYSTEM

MARKETING CONSIDERATIONS

A. PRINCIPAL FEATURES

The principal advantages of Videograph computer page printing equipment are:

HIGH-SPEED

12" to 17.5" per second (web) - - - - - 15,625 characters/second

FLEXIBILITY

Unlimited type fonts	Printing & Plotting
Upper/lower case	90° character rotation
Variable size & spacing	Reverse imaging (for reproduction)
Changeable type fonts	Form imprinting
Proportional spacing	Cut, roll, or fan-fold output

RELIABILITY

Inertia-free - - - - - Continuous - - - - - Noiseless

B. COMPETITIVE PRINTERS

IMPACT TYPE

Competitive high-speed impact printers include the IBM chain printer, drum printers manufactured by the principal computer manufacturers, or drum printers sold as OEM equipment by Analex Corporation.

NON-IMPACT TYPE

The Xeronic printer (manufactured by Rank in England) and the SC4020 (manufactured by General Dynamics/Electronics) are the principal competitors in high-speed and computer-oriented printing equipment. The SC-4020 is primarily designed for microfilm recording, but the output is sometimes used for the preparation of a printing master.

C. PERFORMANCE COMPARISON

The inherent high-speed of Videograph printers results in very high output capacity. The following table shows output in millions of lines per month on a one-shift basis, at several web speeds and line densities:

MODEL 904 VIDEOGRAPH PRINTER — PRODUCTION CAPACITY
MILLIONS OF LINES PER MONTH

LINES PER VERTICAL INCH	WEB SPEED — INCHES PER SECOND 12"	15"	17.5"
6	44.9	56.0	65.5
7	52.4	65.5	76.4
8	59.8	74.5	87.0
9	67.4	84.1	98.0

Equivalent monthly production capacity of impact printers of several rated speeds, and the comparative capacity increase of a Videograph printer, are:

RATED SPEED LINES PER MINUTE	LINES PER MONTH (MILLIONS)	CAPACITY RATIO
300	3.1	14X - 36X
600	6.3	7X - 17X
900	9.5	5X - 12X
1200	12.5	3X - 9X

To increase output speeds, the paper transport systems of impact printers often have a higher speed capability than is permitted while printing. This permits "slewing" or skipping over gross non-print areas. For example, one type of 600 LPM printer (1.6" per second web speed) has a slewing speed of 75" per second which becomes operable after two lines of blank printing. In order for an impact printer with a slewing feature to match Videograph speeds, the page format must be as low as two printed lines on each 11" long page. Since such conditions would rarely prevail, the effect of slewing in comparing impact printers with Videograph performance is considered insignificant.

D. PRICE INFORMATION

EQUIPMENT

A. B. Dick's current marketing experience has been of an exploratory nature, directed to end-users. For this reason, pricing has been established largely in terms of single unit design and manufacture. The following price and rental information present current bench-marks, and serves as a conservative basis for the economic analysis that follow. It must be noted, however, that the pricing does not reflect cost reductions obviously possible with increased production and higher unit requirements of O.E.M. marketing.

Current prices and rentals of a typical Videograph printing system (as shown in Figure 14) f.o.b. Niles, Illinois are:

QUANTITY	DESCRIPTION	PRICE	*MONTHLY BASE RENTAL
1	A. B. Dick Model 9300 Tape Unit	$21,400	$ 450
1	A. B. Dick Model 9404 Printer Control Unit	53,500	1,430
1	A. B. Dick Model 9041 Printer/Plotter	98,500	4,305
	TOTAL	$173,400	$6,185

* 36 month basis including full maintenance.

Extra shift rate = $\frac{40\% \times \text{Base Rental}}{173}$

OPERATING SUPPLIES

Operating supplies for the Model 904 printer comprise Videograph paper and liquid developer, available from A. B. Dick Company. Supply prices depend on quantity requirements but approximate $0.01 per linear foot of 8 1/2" wide paper including developer.

WARRANTY

Videograph equipment is warranted against defective workmanship and materials for a period of one year after acceptance, exclusively of electron tubes and other parts covered by the warranty of their own manufacturer.

DELIVERIES

Delivery of Videograph page printing equipment currently requires ten to twelve months, following receipt of a contract or letter of intent.

E. COST COMPARISON-VIDEOGRAPH vs. IMPACT PRINTING

Figure 17 compares Videograph printing and impact printing for ten hypothetical loading conditions. For this comparison, the total load is assumed to be full page printing at 6 lines per inch, except when otherwise noted (thus the effect of slewing has been neglected). The comparison also assumes that the information printed on the conventional 14" wide impact printer paper can be contained in the 8 1/2" wide field of the Videograph paper, either because of formatting or through the use of horizontal compacting. For simplicity, the economic advantages gained from 90° character rotation are also omitted.

The Videograph system assumed for cases I through V is of the configuration illustrated in Figure 16, including a digital computer as a central processor and both a Videograph Model 904 printer and a 900 line per minute impact printer compatible with the computer. In the comparison, no credit is given the possibility of utilizing the central processor for simultaneous editing work. The cost is charged 100% to printing operations. It should be noted that this simultaneity of operation could not be realized in the case of the compared impact printing system in which the control computer must be used 100% for print control purposes because of its sequential characteristics.

Cases VI through X are based on a Videograph system as shown in Figure 14. This includes a tape unit, a printer control unit, and the Model 904 printer. Equipment rental is based on the information given in Paragraph D. As noted, this is conservatively high and anticipated reductions, due to increased volume, would provide significant increases in the savings reflected. Other factors used in the comparison are defined on the reverse side of Figure 17.

The cost comparisons in Figure 17 show that from a speed standpoint alone, significant and increasing cost reductions in computer printing can be effected with the use of Videograph page printing equipment where the load requires two or more conventional line printers operating in excess of a single shift.

The economic advantage of the electronic line compression feature of Videograph printing is clearly illustrated in Case III. In this example, the monthly load exceeds the two-shift capacity of the Videograph system by 8 million lines. The reflected economics are based on performing part of the load at 7 lines per inch to avoid the necessity of third-shift operation. This effectively reduces monthly costs by $3,629.

The examples in Case I, Case II and Case III also illustrate that further cost reductions result from the use of sequential Videograph printing to replace (where feasible) work normally performed with multi-part forms.

Indirect cost reductions are also achieved by eliminating post-printing operations including bursting, separating, collating, and slitting. Still further reductions are possible with electrostatic form imprinting which eliminates forms handling and inventory facilities.

Lower space and power requirements have not been considered in the Figure 17 analysis.

F. TYPICAL CASE HISTORIES

The following applications have been taken from current Videograph sales files, and reflect the indicated savings that could be effected by Videograph printing systems based on economic factors and system analysis developed during the sales effort.

INSURANCE COMPANY

Two 1401/1403 printing sub-systems are presently used in the EDP operations of a large insurance company to produce approximately 296,000 pages of statements and declarations. The required machine time for these two systems is 595 hours.

FIGURE 17. COMPARITIVE CO

(Cases

	CASE I		CASE II	
MONTHLY PRINTING LOAD (lines)	75 MILLION 60% 3 PART 40% 1 PART		75 MILLION 70% 3 PART 30% 1 PART	
System Type	IMPACT	VIDEOGRAPH	IMPACT	VIDEOGRAPH
Load Distribution	19M lines — 3 part	30M lines 1 Part 78M lines 3 Part	19M lines — 3 part	23M lines 1 Part 99M lines 3 Part
System Required	6	1	6	1
Shifts Required	2	2	2	2
Rental	$35,100	$13,797	$35,100	$13,797
Supply Costs	31,780	23,049	25,070	25,050
Labor Costs	12,456	6,228	12,456	6,228
Total Costs	$69,336	$43,074	$71,626	$45,075
MONTHLY SAVINGS	**$26,262**		**$26,551**	

(Cases V

	CASE VI		CASE VII	
MONTHLY PRINTING LOAD (lines)	20 MILLION 50% 3 PART 50% 1 PART		20 MILLION 50% 5 PART 50% 1 PART	
System Type	IMPACT	VIDEOGRAPH	IMPACT	VIDEOGRAPH
Load Distribution	None	10M lines 1 Part 30M lines 3 Part	None	10M lines 1 Part 50M lines 3 Part
Systems Required	2	1	2	1
Shifts Required	1.5	.6	1.5	.9
Rental	$10,350	$ 6,055	$10,350	$ 6,055
Supply Costs	5,130	5,560	8,460	8,340
Labor Costs	3,114	1,246	3,114	1,868
Total Costs	$18,594	$ 12,861	$21,924	$ 16,263
MONTHLY SAVINGS	**$5,733**		**$5,661**	

T ANALYSIS-VIDEOGRAPH vs. IMPACT PRINTING

I through V refer to Figure 16)

CASE III		CASE IV		CASE V	
75 MILLION 80% 3 PART 20% I PART		50 MILLION 80% 3 PART 20% I PART		25 MILLION 80% 3 PART 20% I PART	
IMPACT	VIDEOGRAPH	IMPACT	VIDEOGRAPH	IMPACT	VIDEOGRAPH
19M lines — 3 part	15M lines I Part 123M lines 3 Part	19M lines — 3 part	10M lines I Part 64M lines 3 Part	9.3M lines — 3 part	5.2M lines I Part 34.5M lines 3 Part
6	1	4	1	4	1
2	2	2	2	1	.6
$35,100	$13,797	$23,400	$13,797	$18,000	$13,797
26,800	24,470	17,800	12,360	9,269	9,440
12,456	6,228	8,304	6,228	4,102	1,868
$74,356	$44,495	$49,504	$32,385	$31,371	$25,005
$29,861		**$17,319**		**$6,366**	

I through X refer to Figure 14)

CASE VIII		CASE IX		CASE X	
20 MILLION 75% 3 PART 25% I PART		12 MILLION 50% 3 PART 50% I PART		8 MILLION 50% 3 PART 50% I PART	
IMPACT	VIDEOGRAPH	IMPACT	VIDEOGRAPH	IMPACT	VIDEOGRAPH
None	5M lines I Part 45M lines 3 Part	None	6M lines I Part 18M lines 3 Part	None	4M lines I Part 12M lines 3 Part
2	1	1	1	1	1
1.5	.8	2	.4	1.3	.25
$10,350	$ 6,055	$ 5,850	$ 6,055	$ 4,905	$ 6,055
7,128	6,950	3,078	3,336	2,052	2,224
3,114	1,661	2,076	830	1,349	519
$20,592	$14,666	$11,004	$10,221	8,306	$ 8,798
$5,926		**$783**		**-$492**	

COST COMPARISON FACTORS

IMPACT SYSTEM (1401/1403)	VIDEOGRAPH SYSTEM	
	Fig. 14 configuration	Fig. 16 configuration
MONTHLY CAPACITY ONE SHIFT		
Impact printer - 600 lines per minute = 6.5 million lines/month	Videograph printer - 6 lines/in. x 17.5" sec. = 65 million lines/month	Videograph printer - 6 lines/in. x 17.5"/sec. = 65 million lines/month Line printer - 900 lines per minute = 9.3 million lines/month
MONTHLY RENTAL PER SYSTEM		
Base Rental = $4,500/month Premium time rate = 30% base rental / 173 $78/hr.	Base rental = $6,055/month Premium time rate = 40% x base rental / 173 $140/hr.	4 - Tape units $1,800 1 - Tape control unit 425 1 - Central processor 1,925 1 - Interface unit 110 1 - Printer control unit 625 1 - Videograph printer 4,305 1 - Line printer 965 Base rental - $9,855 Premium time rate = 40% base rental / 173 = $228/hr.
OPERATING SUPPLIES		
11" x 14" paper - -1 part @ $5,00/M = $84/million lines 13 part @ $25.00 per M= $417/million lines -5 part @ $45.00/M = $750/million lines Ribbons @ $15 - 65 hr. life = $6/million lines	Vid. paper & developer - @ $0.01/sq. ft. = $139/million lines	Vid. paper & developer - @ $0.01/sq. ft. = $139/million lines Impact printer paper 7 ribbon - Same as column 1
OPERATORS PER SHIFT		
One	Two	Three
LABOR AND BURDEN RATE		
$6.00/hr.	$6.00/hr.	$6.00/hr.

The same load is produced in 38.2 hours by a Videograph system as shown in Figure 15. The comparative economics are:

	PRESENT SYSTEM 2 - 1401/1403's	VIDEOGRAPH SYSTEM
Equipment Rental	$ 8,308	$ 7,500
Operating Labor & Burden	4,498	1,125
Operating Supplies	1,246	2,430
Total Monthly Cost	$14,052	$11,055
	11,055	
Monthly Cost Reduction	2,997	
ANNUAL SAVINGS	$35,864	

DIRECTORY PUBLISHER

A major publisher edits and reprints approximately 900 city directories annually — a primary part of its business. The directory pages list names and addresses surrounded by box advertisements. The total printing load is approximately 24,000,000 lines per month.

To gain the advantages of EDP file up-dating, the publisher is presently using an IBM 1401/1403 off-line printing sub-system, at approximately $7000 per month rental, to print-out the information for 200 directories. The 1403 output — in conventional upper case form — is manually pasted-up with the advertising copy. The resulting reproduction dummy is then photographically reduced 30% and transferred to an offset master for printing.

Three additional 1401/1403 systems would be required to produce the total directory volume on a two-shift basis.

One major drawback is an unfavorable customer reaction to the reduced readability and increased book-size of the computer composed directories.

A Videograph system (Figure 15) employing the techniques described in Section VI under Graphic Arts Characteristics replace the four 1401/1403 systems. The comparative economics are:

	1401/1403 SYSTEMS	VIDEOGRAPH SYSTEM
Equipment Rental	$ 36,400	$ 15,120
Operating Supplies	3,000	2,084
Operating Labor	16,192	5,436
Total Monthly Cost	$ 55,592	$ 22,640
	-22,640	
Monthly Cost Reduction	$ 32,952	
ANNNUAL SAVINGS	$395,424	

BROKERAGE

A large brokerage house uses six 1401/1403 printing sub-systems (monthly rental approximately $6,000 each) to prepare month-end statements. This is approximately 75 million pages per month, each page averaging 14 printed lines. Each printing system is required for 49 hours to meet this peak load.

Extraordinary effort has been made to shorten the printing cycle. For example, the form was re-designed so that the address information is printed on the side of the form instead of the top. This resulted in a 14" wide form requiring additional folding steps, and increasing supplies expense.

The same peak load requires only two Videograph systems (Figure 15) operating 31.3 hours each using an 8 1/2" wide form. Substituting Videograph printing systems for three or more of the present 1401/1403 systems gives these results:

COMBINED VIDEOGRAPH & 1403 SYSTEMS

	PRESENT 6-1403's	3-1403's 2-M904's	2-1403's 2-M904's	1-1403 2-M904's
Equipment Rental	$36,000	$31,000	$25,000	$19,000
Operating Labor	15,648	13,140	10,432	7,824
Total	$51,648	$44,140	$35,432	$26,824
Monthly Cost Reduction		$ 7,508	$16,216	$24,824
ANNUAL SAVINGS		$90,096	$184,592	$297,888

Additional cost reductions result from eliminating post-printing operations, operating supplies, and some space and power requirements.

MAGAZINE PUBLISHER

A major publisher employs four 1401/1403 printing sub-systems to produce subscription reference lists, billings, and address-labels. The principal load is a single-copy print-out of names and addresses of 14 million subscribers.

Average monthly load of the four impact printers is 2000 hours, or approximately 70 million lines. The reference lists are presently printed on 11" x 14" forms at a character density of 60 characters per square inch.

Utilizing Videograph printing at 15 characters per horizontal inch, and 8 lines per vertical inch in 8 1/2" x 11" page format, saves 30% of the total number of pages printed per month.

The substitution of a Videograph page printing system (Figure 16) effects these direct cost reductions:

	PRESENT 1401/1403 SYSTEM	VIDEOGRAPH SYSTEM
Equipment Rental	$16,000	$ 9,855
Operating Supplies	6,480	3,342
Operating Labor	8,000	12,170
Total Monthly Cost	$30,480	$25,367
	-25,367	
Monthly Cost Reduction	$ 5,113	
ANNUAL SAVINGS	$61,356	

BANK

A Pittsburgh bank uses four 1401/1403 off-line printing sub-systems on a three-shift basis and needs additional printing capacity to accommodate its growing load. One of the largest jobs performed on the system is a daily load register consisting of single line entries of 128 characters. The register presently contains approximately 72,000 entries. It is anticipated that this will grow to 100,000 lines by the end of 1965. The print-out must be made at the end of each banking day between 9:00 p.m. and 2:00 a.m.

The register is a single copy record and is presently produced in conventional impact printer format. Videograph formatting at 15 characters per horizontal inch, and 8 lines per vertical inch is acceptable and results saves 30% in operating supplies and file volume.

A Videograph system (Figure 16) replaces the four impact printers at the cost reduction shown below. The load register job could be performed in less than 15 minutes with Videograph.

	1401/1403 SYSTEM	VIDEOGRAPH SYSTEM
Available 3-shift capacity Millions of lines per month	69.1	155.5
Equipment Rental	$32,000	$17,739
Operating supplies (3-part average)	29,187	28,800
Operating Labor	25,000	12,500
Total Monthly Cost	$86,287	$59,039
	59,039	
Monthly Cost Reduction	$27,248	
ANNUAL SAVINGS	$326,976	

G. APPLICATION FOR VIDEOGRAPH PRINTING

The application of Videograph page printing can be broadly categorized as follows:

- EDP activities requiring high-speed plotting, as well as page printing.
  EXAMPLES: Telemetry
  Engine testing
  Gas and oil line supervision
  Process control
  Data reduction and logging

- Existing EDP printing operations in which the load of the system exceeds 8,000,000 lines per month and requires two or more impact-type printers of at least 600 lines per minute capacity, in excess of one-shift operation.

- EDP printing activities requiring multiple impact-printers because of peak loads or short printing cycles.
  EXAMPLES: Daily banking registers
  Subscription fulfillment reference lists
  Computer "dumping" operations

- New applications in which the formatting flexibility and graphic arts characteristics of Videograph printing will open new uses for digital computers.
  EXAMPLES: Extended copy applications
  Graphic arts proofing
  Directory publishing
  Transportation schedules
  Price lists
  Service manuals

POTENTIAL USES

ADDRESS LABELS
BILLS OF MATERIALS
BUSINESS DIRECTORIES
CHECK IMPRINTING
CITY DIRECTORIES
DEMAND DEPOSIT ACCOUNTING REGISTERS
DIRECT MAIL CATALOG
DIRECT MAIL LISTS
ENGINEERING ANALYSIS
ENGINEERING DRAWING LISTS
FINANCIAL STATEMENTS
GENERAL ACCOUNTING DATA
INTERCEPT LISTS AND CHANGE IN SERVICE RECORDS
INVENTORY STATUS REPORTS
INVOICE AND STATEMENTS
LIBRARY CATALOGUES
LOAD REGISTERS
MANUSCRIPT PROOF
PARTS LISTS
PERT CHARTING
PRICE LISTS
PROCESS CONTROL DATA
PROGRAMMING CHECKS
RATE AND TARIFF TABLES
RECORD CATALOGUES
SALES FORECASTS
SCIENTIFIC DATA
SCIENTIFIC TABLES AND REFERENCE MATERIAL
SERVICE MANUALS
SPECIFICATIONS
SUB-SCRIPTION FULFILLMENT LISTS
TELEPHONE DIRECTORIES
TELEVISION AND RADIO SCHEDULES
TEST DATA
TRADE DIRECTORIES

POTENTIAL USERS

AEROSPACE
AIRLINES
BANKS
BOOK PUBLISHERS
BROKERAGES
CATALOG PUBLISHERS
CREDIT ORGANIZATIONS
DIRECT MAIL HOUSES
DIRECTORY PUBLISHERS
EDP SERVICE CENTERS
GOVERNMENT CONTRACTORS
HOSPITALS
INDEPENDENT RESEARCH AGENCIES
INSURANCE
INTERATED RETAILERS
LOAD AGENCIES
MAGAZINE PUBLISHERS
MAIL ORDER
MANUFACTURERS
MUNICIPLE GOVERNMENT AGENCIES
NEWSPAPERS
OIL REFINERS
PRINTERS
PROCESSING
RAILROADS
STATE GOVERNMENT AGENCIES
TITLE AND TRUST
TRUCK LINES
TYPOGRAPHICAL SERVICE CENTERS
UNITED STATES GOVERNMENT AGENCIES - CIVIL
UNITED STATES GOVERNMENT AGENCIES - DEFENSE
UNIVERSITIES
UTILITIES
WHOLESALERS
WIRE SERVICES

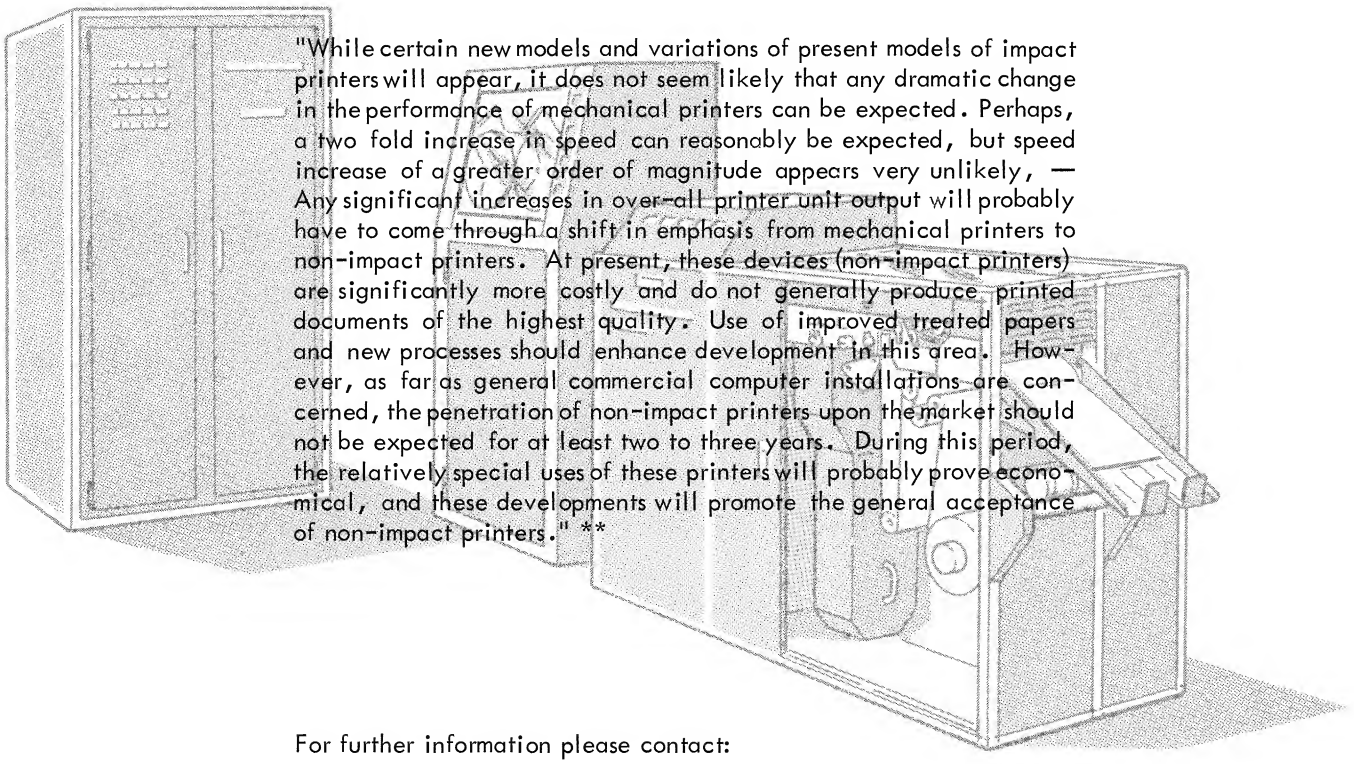
H. MARKET CHARACTERISTICS

Videograph market sampling by A. B. Dick Company during the last two to three years has provided a clear indication of general interest in high-speed EDP printing, and has permitted the identification of a variety of specific applications as illustrated in previous sections. A broader program to determine the extent of the market, to seek further application information, and to develop design criteria is now underway.

Videograph printing equipment is of specific interest to EDP supervisory personnel, persons responsible for the evaluation and selection of EDP equipment, and systems and procedures representatives.

The importance of graphic arts capabilities in extending computer usage to new applications is more difficult to assess because of the inexperience of EDP personnel regarding printing requirements in extended-use copy applications. On the other hand, there is growing interest in computer usage in the printing and publishing fields, both captive and independent, especially if the output has graphic arts characteristics to which printers are accustomed.

In view of A. B. Dick Company's experience, the market attitude towards non-impact printing in the EDP field is accurately stated in the following quote from a report published in 1963 by a leading management consulting firm:



"While certain new models and variations of present models of impact printers will appear, it does not seem likely that any dramatic change in the performance of mechanical printers can be expected. Perhaps, a two fold increase in speed can reasonably be expected, but speed increase of a greater order of magnitude appears very unlikely, — Any significant increases in over-all printer unit output will probably have to come through a shift in emphasis from mechanical printers to non-impact printers. At present, these devices (non-impact printers) are significantly more costly and do not generally produce printed documents of the highest quality. Use of improved treated papers and new processes should enhance development in this area. However, as far as general commercial computer installations are concerned, the penetration of non-impact printers upon the market should not be expected for at least two to three years. During this period, the relatively special uses of these printers will probably prove economical, and these developments will promote the general acceptance of non-impact printers." **

For further information please contact:

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Telephone: ROdney 3-1900

** Auerbach/BNA Special Report — "State-of-the-art of High-speed Printers" (1963)